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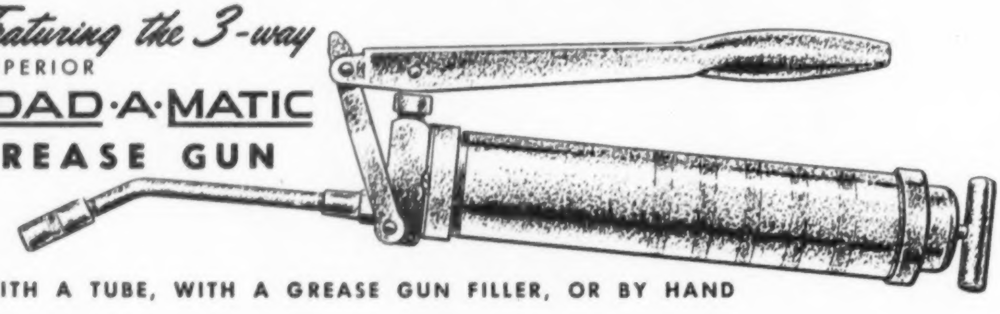

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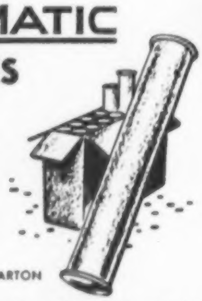

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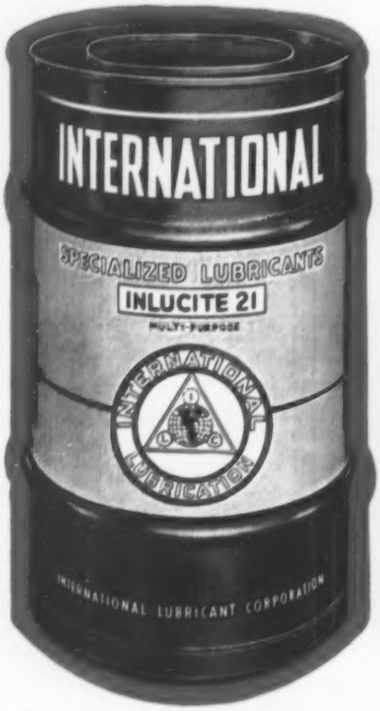

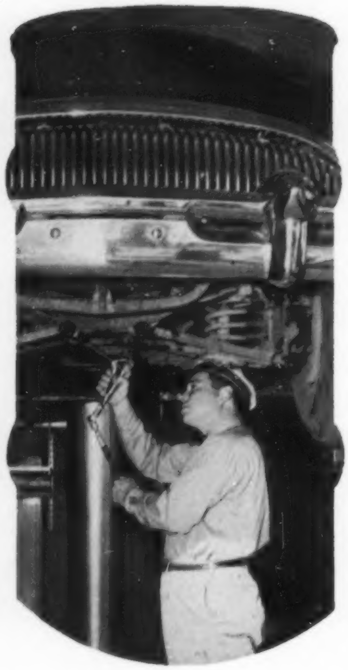

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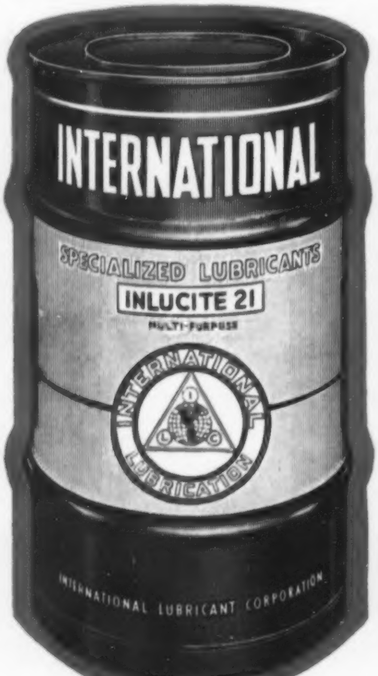

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President's page

by W. M. MURRAY, President, N L G I

We Cannot Be Complacent and Progress

There is growing recognition on the part of the Institute membership of the importance of sales promotion. Even where lubricating grease is definitely the superior lubricant for a specific application our product will neither sell itself nor find its own new uses. We have to sell; we have to explore; and we have to evaluate new applications.

Industrial and automotive trends toward the replacement of lubricating greases with lubricating oils may or may not be patterned accidentally. Trends indicate the need for industry change from complacency to investigative action.

This subject may not seem of too great importance to the integrated petroleum industry in position to supply both types of products. Certainly it is important to grease and grease equipment manufacturers, large or small. According to the Department of Commerce total motor vehicle registrations for 1955 will be greater than 61,250,000 vehicles. This number will be increased annually. Industrial indices depict continuing increases in factory productivity. Both augur well for lubricating grease tonnage in the near future, but, do not overlook the fact that small immediate conversions may be the beginning of large later declines.

The story of the superiority of lubricating greases is a true one which may be documented by service and accounting records. It is a much more exciting story than many users suspect. It is a story of accomplishment and progress and it is our story to stand by.

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NLGI Spokesman

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ABOUT THE COVER

Yuma Test Station, spotted on the cover, has an elevation range from sea level to 5,000 feet and ambient temperatures from 80 F to 124 F. Field tests were begun here in 1948 and have continued to the present day. Artist Ronald Jones was intrigued by the description of Yuma field testing in the article "Mechanical Stability of Greases—Bench Tests Versus Field Service," appearing on page 8.

Mechanical Stability of Greases

Bench Tests Versus Field Service

By

S. F. CALHOUN and F. E. WOODWARD

Rock Island Arsenal

Authors S. F. Calhoun, left, and F. E. Woodward

This paper was presented at the ASTM Symposium, Technical Committee G, Houston, Texas, February 16, 1955, as part of the second section entitled "Correlation of Laboratory Tests with Simulated and Field Service."

ABSTRACT

The results of laboratory tests for mechanical stability on MIL-G-10924 Amendment I and II greases are compared. These results are found to correlate with field service tests conducted at Yuma Test Station and at Southwest Research Institute, San Antonio, Texas. Results of field tests for the three years 1952 to 1954, inclusive, are summarized.

FOR the purpose of this paper, mechanical stability is considered as being indicated by changes in consistency resulting from working grease. The correlation between bench tests and field service will be restricted to the ASTM Worker and the Shell Roll tester for laboratory testing and to the truck wheel bearings for field service.

The question of correlation between bench test and service experience has long been one of prime importance to both the manufacturer and user of greases. Field tests are expensive, time consuming, and beset with hard-to-control variables. As an example, a panel

working under the National Lubricating Grease Institute has for the past several years been gathering information on and studying the practice of wheel bearing lubrication. Their conclusions are that three out of five wheel bearing failures are caused by factors other than the lubricant itself.[1] Some factors mentioned are:

1. Contamination of the lubricant from various sources.

2. Lack of attention to mechanical details, such as improper seating or tightness of the bearing.

3. Too much lubricant.

Recognizing the need for such information from the field, the Army Ordnance Corps has been conducting field tests of various lubricants in motorized equipment during the past few years. The results of this testing, while stated in general terms, correlate very well with bench tests made on the greases used. In Table I are given results of laboratory tests on six qualified MIL-G-10924 Amendment I and II greases, chosen randomly from the entire group.

disclosed the necessity of improving the mechanical stability, lubricity, and bleeding of Amendment I greases. The lubricity was considered to be borderline, due to considerable darkening and staining of the bearings, although there were but few cases of pitting or spalling, and no complete failure.

At this point it would probably be well to mention certain findings in stored vehicles. Some greases, which had given excellent field results, when used in stored vehicles permitted oil leakage from the constant velocity joints. This oil dripped down on the sidewalls of the tires. Since a number of tires had to be replaced, this situation naturally caused some concern. This problem of bleeding is being studied at the present time.

The field testing program began in 1948 and has continued since. The first testing was done with the object of setting up specifications, which became MIL-G-10924. The first actual testing of greases made to this specification began in 1952 with the testing of three greases at the Yuma Test Station. Elevations ranged from sea level to 5,000 ft. and ambient temperatures from 80 F to

TABLE I

LABORATORY TESTS ON MIL-G-10924 AMENDMENT I AND II GREASES

	10924 (Amend. I)		10924 (Amend. II)		
Grease Mfr.	*Unworked Penetration*	*Penetration Change**	*Unworked Penetration*	*Penetration Change**	*Penetration Change***
A	290	+106	290	+4	+52
B	343	liquid	287	+7	−7
C	289	+11	267	+4	+8
D	295	+113	295	+8	+15
E	303	liquid	272	+47	+33
F	292	+48	262	+22	+38

Penetrations made at 77 F

*After 100,000 strokes on ASTM Worker
**After 100 hours at 150 F on Shell Roll Tester
+ indicates softening, − indicates stiffening

The 10924 Amendment I greases were in use prior to 1953. The specification contained no provision for any work stability test except a worked penetration maximum of 350 after sixty strokes in the ASTM Worker. A 100,000 stroke worker test was made in the laboratory as a routine procedure and the change in penetration after this test is given in column 3 of Table I.

Amendment II became effective on the 10924 specification early in 1953. It contained limits upon unworked as well as worked penetration and a mechanical stability requirement involving the Shell Roll Tester. The Roll Test was adopted as it was believed to be a more rugged test and to simulate service conditions more closely than the ASTM Worker. Extensive testing in the laboratory disclosed good correlation between the two machines and somewhat better control of conditions for the Roll Tester. Column 5 in the table gives the change in penetration after the Worker Test and column 6 the change after the Shell Roll Test. All penetrations were made at 77 F.

It is evident from these values that Amendment II greases are generally superior to Amendment I greases from the standpoint of mechanical stability. Amendment II was adopted after field tests made in 1952 had

124 F. The highest recorded bearing temperature was 260 F. The test fleet consisted of various type trucks, and each vehicle accumulated approximately 10,000 miles during the test. The brakes had to be relined two and three times during the test. The three greases selected—two lithium and one anhydrous calcium soap—were chosen on the basis of laboratory tests which indicated for two of the greases a relatively high shear stability. Inspection at the conclusion of the test revealed general, undue softening of the grease, bearing discoloration, and oil separation. The following recommendations were made:

1. The greases should be improved from the standpoint of mechanical stability.

2. Their stability toward bleeding should be improved.

3. Improvements in compounding should be made in order to eliminate the tendency toward borderline lubrication. These recommendations resulted in the adoption of Amendment II as mentioned previously.

The 1953 tests were run both at San Antonio and at Yuma on MIL-G-10924 (Amendment II) greases which had passed the work stability tests. In September 1953, inspection of the test results was held at Southwest Research Institute, San Antonio, Texas. Four greases were

under test here, primarily for wheel bearing performance. Of the four greases, one was calcium, one lithium, one lithium-calcium, and the fourth a blend of the calcium and lithium-calcium soap greases. The vehicles were ¾, 2½ and 5 ton trucks and the mileage was 30,000 for each vehicle. Inspection showed that the lithium soap grease had softened and showed evidence of bleeding. The other three gave satisfactory performance. The bearings in all cases were in good condition.

Inspection was next made at Yuma on a number of assorted vehicles which were lubricated with eight greases of the MIL-G-10924 (Amendment II) type and one standard wheel bearing grease, MIL-G-2108. The procedure at Yuma had been modified from that of previous tests. The inner wheel bearing seals of five of the vehicles were slotted and the vehicles used in fording operations of the Colorado River. Following this test, in which all greases gave poor results, the bearings were all replaced and relubricated. The vehicles were then operated in Death Valley to complete 3,000 miles and then returned to Yuma to finish out 9,500 miles. Inspection was made on October 2 and 3, 1953.

The overall picture of the grease performance under dry conditions was good. The results of the fording operations, which rated all greases poor, were omitted in evaluating both grease and bearings. The conditions were considered too extreme, as much silt entered the bearing with the water. The inspection committee reported that there was a definite improvement in grease performance over previous tests, with better stability and fewer cases of borderline lubrication.

In 1954 two MIL-G-10924 (Amendment II) greases were tested in 15 standard Ordnance wheeled vehicles. Grease X was one which showed considerable bleeding in static storage. Grease Y exhibited little or no oil separation under similar conditions. The test consisted of accumulating 10,000 miles on each vehicle over a varied, mountain-desert road, including a portion in Death Valley. No fordings were accomplished, hence no rust preventive properties were checked. The conclusions of the inspection committee were as follows:

1. On the basis of lubrication, both greases were considered to be satisfactory, since there were no failed or completely dry bearings.
2. Grease X tended to soften more in both bearings and hubs than grease Y. In the case of trailers there was somewhat more softening of both greases than for the corresponding trucks.
3. Grease X showed a greater tendency than grease Y to separate oil in the hubs.
4. More fretting corrosion occurred on bearings and spindles where grease Y was used.
5. The heavier the truck or trailer, the greater the softening of the grease and the less the fretting corrosion.
6. Grease leakage occurred from hubs for both greases, but not all hubs showed leakage. There was no apparent trend differentiating the two greases in respect to leakage.

Based on the tests enumerated, it is seen that the results from field testing correlate well with the bench tests made on MIL-G-10924 greases. The two bench tests made indicated general superiority in favor of the Amendment II greases. In a general way field tests also rated them better than their predecessors. Whether this improvement was due to a better grade of components, higher soap percentage, or to better manufacturing methods was not determined. Of primary importance to the grease consumer is that a reliable indication of grease performance can be obtained in a relatively short time by bench tests.

Literature Cited for References

1. Proudfoot, D. G., "Analyzing Wheelbearing Complaints" NLGI Spokesman, Vol. 15, No. 9, Dec. 1951, pp 8-17.

Correlation of Bench Tests of Lubricating Grease with Service Tests in Wheel Bearings

By C. J. BONER, HUGH E. HALE
and GLEN A. WILLIAMS
Battenfeld Grease & Oil Corporation

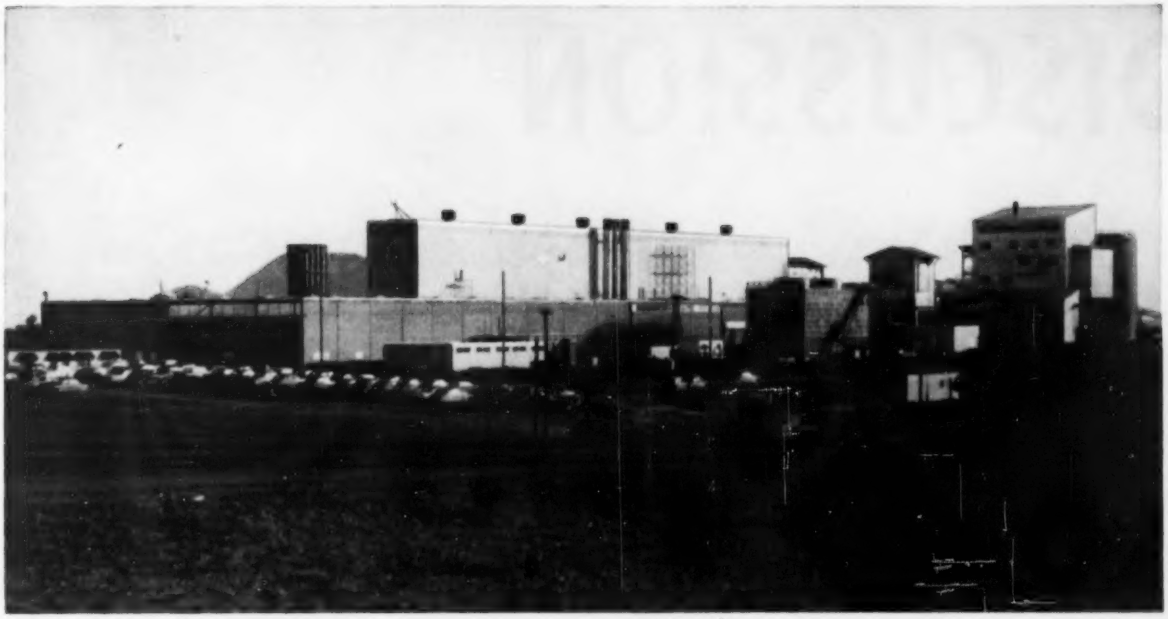
This paper was presented at the ASTM Symposium Technical Committee G, Houston, Texas, February 16, 1955, as part of the second section entitled, "Correlation of Laboratory Tests with Simulated and Field Service."

ABSTRACT

Three lubricating greases, a No. 2 NLGI Grade of Complex Barium Base, a No. 1 NLGI Grade of Lithium Base, and a No. 2 NLGI Grade of Lithium Base were subjected to both bench tests and road tests to determine if the two types of tests correlated.

For the specific lubricants tested, mileages of 20,000 to 50,000 correlated the results obtained on Wheel Bearing Test Machines. Since no failures were obtained, either in service or on bench tests, this work gives no clue as to whether a product rating poor in the Laboratory would prove satisfactory in service.

Some loss of stability was observed on all of the lubricants when subjected to either 10,000 strokes in an ASTM Grease Worker or to the action of a Shell Roller. Therefore, some loss of stability in such tests does not necessarily indicate a resulting poor service performance.



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DISCUSSION

Symposium Papers Presented in Section II

By P. R. McCARTHY
Gulf Research & Development Company

Symposium on Mechanical Stability of Lubricating Greases ASTM D-2 Technical Committee G, February 16, 1955

In all probability, the majority of people intimately connected with the development, production and ultimate use of greases will agree that the ability of a grease to remain at the point of application depends on:

1. Its original consistency.
2. Its resistance to change in consistency.

Anyone who has dealt with greases for more than several days will probably agree that other individual factors or combination of factors in addition to pure mechanical working can and do affect the consistency of greases, either in performance tests of the laboratory type or in service.

The papers presented during this portion of the Symposium indicate that considerable time, thought and effort have been directed toward determining the practical significance of information developed through the use of laboratory shear stability tests and the relationship of this information to actual performance in service. It is quite obvious from the papers presented that there is a divergency of opinion concerning this correlation.

Reviewing the papers in order of their presentation:

Paper No. 8—Mr. E. M. Higgins

Mr. Higgins has done an excellent job in pointing out the almost innumerable types of conditions to which a grease may be subjected.

Briefly summarized, all of the following factors can affect the mechanical or chemical characteristics of a grease in service:

1. Type, size and speed of bearings.
2. Type of operation—cyclic or continuous.
3. Temperature—constant or variable, high or low.
4. Bearing housings and/or shields—tight or loose.
5. Materials of construction—compatible or noncompatible with lubricants.
6. Mechanical aspects—fit of mating parts, alignment, vibration, etc.
7. Contamination with materials from various sources.
8. Human elements—right or wrong lubricant for a particular application, too much or too little lubricant, combinations of incompatible greases in the same system, etc.

In view of the above, it is always a constant source of amazement that grease producers are not constantly deluged with complaints. Also, in view of these factors, I thoroughly agree with Mr. Higgins as to the extent of possible correlation between the shear stability of greases

Correlation of Laboratory Tests with Simulated Field Service

as currently determined by laboratory tests and performance in service. Certainly there are so many other variables which can and do affect performance, especially over prolonged periods, that the effects of purely mechanical shear may be negligible.

Mr. Higgins' analysis of the situation applying to shear stability, as currently determined, versus performance in service is so thorough that anything further which might be added in the same vein would be superfluous.

Paper No. 9—Mr. J. M. Musselman

Mr. Musselman's interpretation of the data persented in his paper appears to be that:

1. Two tests, the worker test and roll test, used to determine the shear stability of greases may not rate the same greases in the same order.
2. There is no correlation between the results of the laboratory working tests described and the mechanical stability of greases as determined in a simulated, freight car, roller bearing test.
3. A need exists for laboratory tests that will more accurately predict the mechanical stability of lubricating greases in service.

Mr. Musselman's data is reproduced as follows:

	Penetration ASTM			Shell Roll Test 16 hrs.			After Bearing Tests	
Sample No.	*Unworked*	*Worked 60,000*	*Points Change*	*Microcone Pen. Unworked*	*Worked*	*Points Change*	*Penetration ASTM*	*Points Change*
1	326	310	−16	180	182	+2	278	−48
2	324	378	+58	178	245	+67	260	−64
3	316	353	+37	165	219	+54	310	−6
4	321	321	0	163	178	+15	263	−58
5	355	358	+3	203	156	−47	260	−95

Several factors should be taken into consideration in the evaluation or analyses of this data:

1. With the exception of Sample No. 5, the comparative rating of the other samples by the worker and roll tests appears to be fairly good. The difference between the cones and methods used for penetration may have some effect on results. The temperatures involved in the Shell Roll Test and treatment following rolling might also affect or alter results of penetration tests.

2. Treatment of the samples following bearing tests and prior to penetration tests also could have affected the correlation between shear stability tests and simulated performance tests. If the samples were transferred from the bearing housings at the test temperature to the worker cup and the sample permitted to cool to 77° F. without further agitation, the increase in consistency for all samples noted by Mr. Musselman may have been due to a false set, which is characteristic of some greases after being subjected to elevated temperatures.

Conditions under which a soft grease can flood into the working areas of a bearing and be subjected to a high shearing action appear to approximate the conditions of shear in the working stability tests. If a true correlation exists between current shear stability tests and shear stability either in service or in simulated service, better correlation should have been demonstrated in Mr. Musselman's tests.

Paper No. 10—Messrs. J. M. Stokely and S. R. Calish

The examples of liquefaction of greases under service conditions and possible reasons for this condition, described by Messrs. Stokely and Calish, are probably fa-

miliar to all of us although the cause for this occurrence is in the majority of cases not obvious.

The possible explanation advanced for liquefaction of wheel bearing greases in heavy duty operation merits consideration. However, it should be remembered that baffles present in the hubs of many heavy duty vehicles and centrifugal action tend to mitigate the rolling action of the grease in the hubs.

Electron micrographs shown by the paper presented by Messrs. Stokely and Calish reveal that definite changes in structure occur in service and that definite agglomerations of soap fibers are present in greases which become fluid in service. It is possible that this condition may be due to chemical changes, induced by high temperatures, contaminants, etc., as well as to high shearing action.

The explanation advanced as to the causes for temporary fluidity of greases in service and the authors' conclusion that results of work stability tests might correlate with excessive leakage from overpacked bearings appear to be sound only if soft, nonchanneling types of greases are considered. It is also agreed that the method specified by MIL-G-10924 for determining the shear stability of greases in the presence of water may be inadequate for predicting the mechanical stability of water-contaminated greases in industrial service. However, the test may not have been developed to predict performance in this type of service.

Messrs. Stokely and Calish concluded that there does not appear to be a direct correlation between shear stability, as determined by laboratory tests, and performance in service.

Paper No. 11
Messrs. S. F. Calhoun and F. E. Woodward

From the data accumulated, Messrs. Calhoun and Woodward have concluded that the results of field service testing correlate very well with laboratory tests on mechanical stability. Their conclusions are based on the laboratory evaluation of one series of greases having relatively poor shear stability and another series having excellent shear stability, as determined by laboratory tests, and the relative performance aspects of the same series of greases when tested in vehicles of the military type.

On the basis of the data reported, no definite conclusions can be drawn as to the relationship of results of working stability tests and performance in this particular application. Superficially, it would appear that several factors may be involved in the general improvement noted in performance characteristics. The difference in penetration data between the Amendment I and the Amendment II greases indicates that the soap content may have been increased in the latter series. The harder consistency of the latter series is also evident. It has been our experience that low soap content greases having soft consistencies give poor performance in bearing applications, regardless of the shear stability exhibited in laboratory tests.

Paper No. 12
Messrs. C. J. Boner, H. E. Hale and G. A. Williams

Correlation between laboratory tests and performance in service depends on the ability to differentiate between characteristics exhibited by the samples in each operation and to establish a relationship between the variations in the characteristics noted.

The data presented by Mr. Boner and his associates do not appear to meet the requirements needed for correlation since all of the samples tested show fair shear stability in worker and roll tests, excellent retention in two simulated performance tests and excellent performance characteristics in heavy duty trucking operations for prolonged periods. Reversals in results of tests in the several operations might be required to establish true correlation, or lack thereof.

From the data presented, Mr. Boner's conclusions that "the fact that some loss of stability was observed with both 10,000 strokes in an ASTM worker and in a Shell Roll Test, indicates that such loss of stability does not necessarily result in poor service performance" can neither be accepted nor rejected.

Conclusion

Whether there is a true correlation between shear stability as determined in current laboratory tests and resistance to consistency change in service appears to be a matter of opinion. The opinions voiced by the authors of the five papers reviewed indicate that four out of the five feel that no true correlation exists.

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SHEAR STABILITY

of Lubricating Greases

By CHARLES A. ZEILER
Aluminum Company of America

This paper was presented at the ASTM Symposium, Technical Committee G, Houston, Texas, February 16, 1955, as part of the third section, "Technical Considerations of Mechanical Stability."

I. Introduction

The complex structure and behavior of lubricating greases become increasingly apparent as progress is made in research on their basic properties. Hence, this Symposium on Shear Stability may be regarded as an excellent means of circulating and distributing information to ASTM members prior to the organization of a contemplated program on this subject.

This paper presents a brief discussion of the shear stress and rate of shear effects involved in lubricating greases when subjected to functional laboratory tests. Because of the nature of the work, however, no direct numerical value for either factor can be given. The data are grouped into the following classifications:

A. ASTM Grease Worker and Shell Roller Tests

(1) Data on a group of preselected greases, all of which have been classified against a certain standard (Alcoa Specification ML-792) as superior.

(2) Data on a group of preselected greases which have failed to pass the above standard but were chosen to illustrate certain points with regard to the shear stress involved in the two machines under study.

B. Oil Separation Under Pressure Test Data

Tabulated data for three lithium base greases, one of which contains an EP additive.

C. Data From an Investigation of the Flow Characteristics of Lubricating Greases Using the Lincoln Automatic Electric Lubrigun

1. "Laboratory Screening of Multi-Purpose Greases for Plant Performance Tests" by E. M. Kipp and C. A. Zeiler, *Iron & Steel Engineer* 28, September, 1951, pp. 107-113.

II. Discussion

A. ASTM Grease Worker and Shell Roller Test Data

Many members of this group may be aware that Aluminum Research Laboratories has set up a specification (ML-792) for the purchase of #2 consistency multi-purpose greases.[1] This specification originated on the principle that an over-all evaluation based on a series of carefully selected laboratory tests would be more likely to predict the industrial value of a given lubricating grease than any one test in itself. The greases listed in Figure 1 have all received a *pass* rating. Data are recorded for the motorized grease worker (10,000 strokes) and for the Shell Roller test (4 hr. test at room temperature). The numerical figures in Columns II and III on the chart

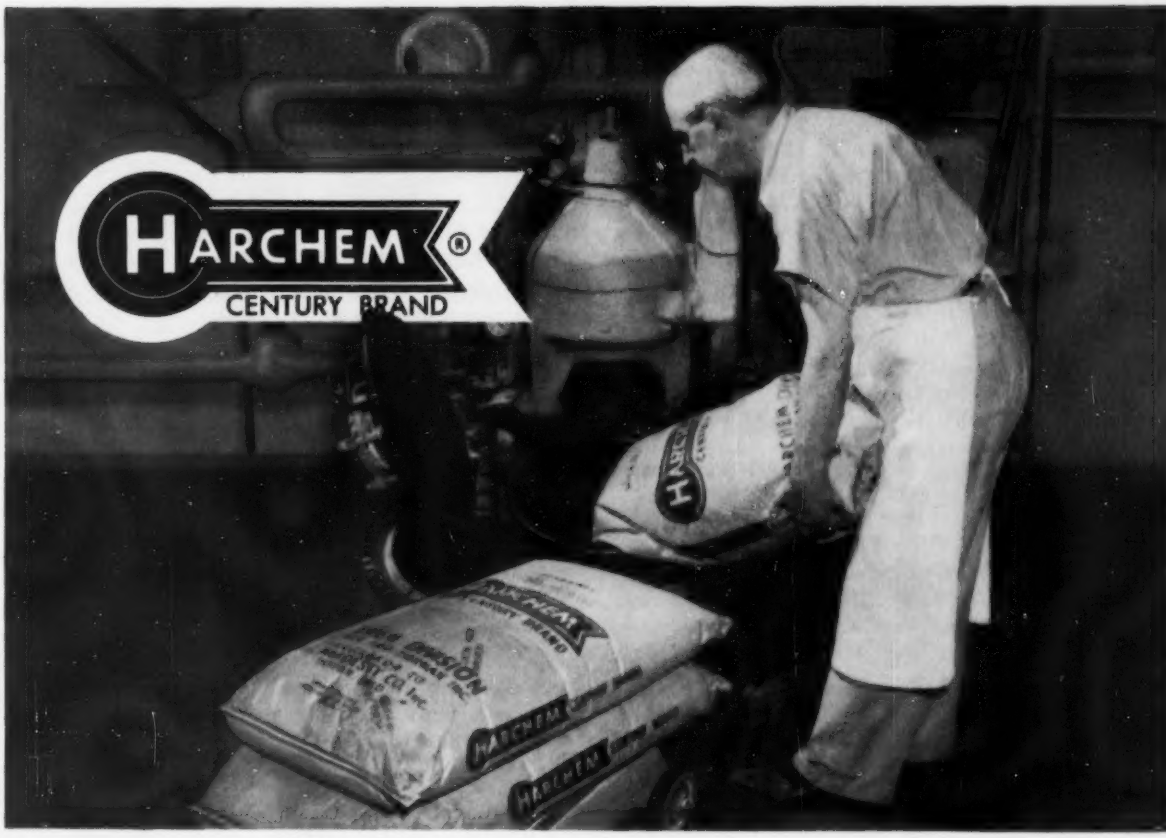
GREASE WORKER AND SHELL ROLLER TEST DATA

GREASES PASSING ALCOA SPECIFICATION ML-792

GREASE TESTED	N.L.G.I. NO.	I SOAP BASE	II GREASE WORKER [1]	III SHELL ROLLER [2]	IV DIFFERENCE (S.R. - G.W.)
1	2	STRONTIUM	8.1 % *	8.9 %	17.0 %
2	1	MIXED	5.7 *	7.2	12.9
3	2	LITHIUM	2.6 *	8.6	11.2
4	2	LITHIUM	2.4 *	3.1 *	0.7
5	2	LITHIUM	0.3	7.3	7.0
6	2	LITHIUM	0.7	7.4	6.7
7	1	LITHIUM	1.0	6.5	5.5
8	2	LITHIUM	2.8	24.7	21.9
9	2	LITHIUM	7.1	37.8	30.7
10	2	LITHIUM	8.7	44.1	35.4
11	2	LITHIUM	11.8	39.0	27.2
12	2	LITHIUM	14.3	37.1	22.8

NOTE 1 - PER CENT CHANGE BETWEEN 60 AND 10000 STROKES
2 - PER CENT CHANGE BETWEEN INITIAL AND FINAL MICRO-PENETRATION
* PER CENT DECREASE

FIGURE 1



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represent the percentage change between the initial and final penetrations on the two machines. This can be illustrated as follows:

Grease Worker

$\frac{P\ 10{,}000 - P\ 60}{P\ 60}$ where

Shell Roller

$\frac{P_F - P_I}{P_I}$ P_I = initial penetration, P_F = final penetration

The figures in Column IV represent the numerical differences (Shell Roller Value—ASTM Grease Worker Value). The soap base of the greases tested is shown in Column I.

GREASE WORKER AND SHELL ROLLER TEST DATA

GREASES NOT PASSING ALCOA SPECIFICATION ML-792

GREASE TESTED	N.L.G.I. NO.	I SOAP BASE	II GREASE WORKER [1]	III SHELL ROLLER [2]	IV DIFFERENCE (S.R.-G.W.)
13	2	SPECIAL LIME	7.5 %	0.0 %	-7.5 %
14	2	SILICA-GEL	43.8	16.0	-27.8
15	1	BENTONE	7.3	1.3	-6.0
16	2	Na - Ca	1.2 *	94.0	95.2
17	2	LITHIUM	1.8	109.4	107.6
18	2	LITHIUM	TOO SOFT	TOO SOFT	—

NOTE 1 - PER CENT CHANGE BETWEEN 60 AND 10000 STROKES
2 - PER CENT CHANGE BETWEEN INITIAL AND FINAL MICRO-PENETRATION
* PER CENT DECREASE

FIGURE 2

A difference beyond the limit of experimental error is evident between the test results from the two machines. Thus, the results show that the Shell Roller constitutes a more severe test than 10,000 strokes on the ASTM Grease Worker.

As the greases become more susceptible to mechanical breakdown on the Grease Worker, the differences between the test results from the two machines become more widely separated. Evidently, the shear stress and rate of shear play important parts in the mechanical breakdown of grease in this test equipment. The different shear stresses characterizing the two test machines are important factors in the different results obtained. Accordingly, if a method for the measurement of shear stress and rate of shear could be developed in the ASTM Grease Worker and Shell Roller test procedures, it is believed that a better understanding of the behavior of lubricating greases when subjected to this type of mechanical breakdown would result.

The greases listed in Figure 2 represent the results of the same tests on greases that did not pass specification ML-792 (although not necessarily failing on the Shell Roller or Grease Worker). They were chosen to illustrate some different effects involved in the two test machines under study. The following comments can be made:

Greases 13, 14, and 15 show an effect opposite that shown in the first 12 in that the per cent increase for the Grease Worker was greater than that for the Shell Roller. In some 150 greases tested—representing barium, lithium, sodium, calcium, aluminum, bentone, silica gel, silicone and various mixed base products—this effect was noticed in only a very few cases, of which the above three are examples. In all cases, only special lime, Bentone, or silica gel base greases were involved.

Greases 16 and 17 show clearly the wide spread between the Grease Worker and Shell Roller results and the resultant effect upon the final ratings. Actually, these greases would have been rated excellent if the Grease Worker test alone had been conducted and the results taken as representative.

Grease 18 rated very poor in mechanical stability because it gave very poor results in both tests. Actually, this product became so soft that a normal penetration test could not be conducted on it in either case. Shear stress and rates of shear certainly are again involved in the foregoing examples.

B. Pressure Oil Separation Test Data

The apparatus used for measuring the oil bleeding from greases under pressure was the pressure oil separation test developed by the Esso Standard Oil Company, and generally described in U. S. Patent 2,653,131. The regulation steel cylinder and piston from the SOD pressure viscometer in combination with a special filtering unit was utilized. The filtering assembly consisted essentially of two layers of No. 1 filter paper clamped together between two perforated brass plates each containing 952 holes per sq. in. The amount of oil bleeding occurring in 22 hours at constant pressure (100 lbs.) was then measured. The results obtained are listed in Figure 3.

Although the amount of this work undertaken was very limited, a marked difference was found among the three greases tested. The initial grease tested (No. 1) showed the most bleeding. However, a similar grease, using the same manufacturing process and soap base but a slightly heavier oil, showed a lesser bleeding tendency. Finally, the initial grease with an EP agent showed very little bleeding compared with the others.

All three of the greases tested passed the specification for multi-purpose greases of No. 2 consistency (mentioned above) and were for this reason judged superior. However, the above data show that their bleeding characteristics under pressure are very different. As the trend towards industrial, automatic, lubrication systems progresses, bleeding properties of a lubricating grease under pressure will become increasingly important. Again, shear stress and rate of shear induced by applied pressure are undoubtedly factors to be considered.

C. Flow Characteristics of Lubricating Greases Using the Lincoln Automatic Lubrigun

The Lincoln Automatic Lubrigun was used to pump the grease under test through different lengths of 15/64" diameter (inside) steel tubing. The delivery end of the tube, however, was partially closed by inserting a plug having a 1/16" opening. Gages were inserted both at the pump and delivery ends of the line. The amount of grease delivered in a given time (30 seconds) was recorded. From the test data, the pounds per sq. in. pressure to pump one gram of grease was calculated as follows:

$$\frac{\text{Pressure Differential}}{\text{Grams of Grease Pumped}} = \frac{P_1 - P_2}{\text{Grams of Grease Pumped}} =$$

lbs/sq. in. pressure required to pump one gram of grease

P_1 = pressure at the pump end

P_2 = pressure at the delivery end

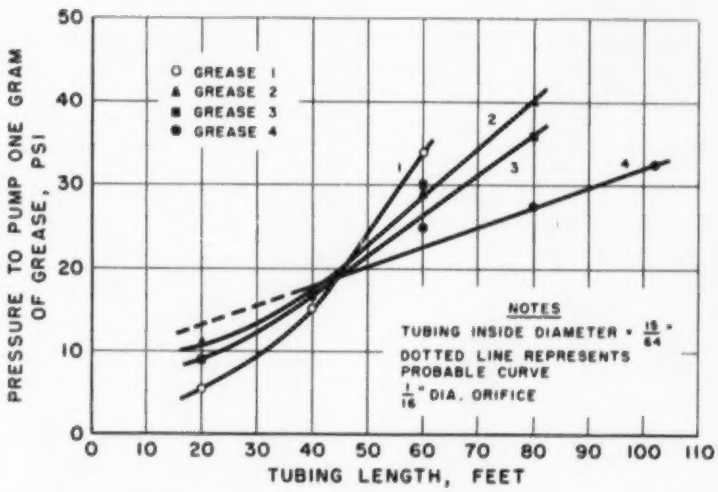
BLEEDING OF LUBRICATING GREASES WHEN SUBJECTED TO PRESSURE

GREASE TESTED	N.L.G.I. NO.	SOAP BASE	BLEEDING GRAMS †
1	2	LITHIUM	11.2
2 *	2	LITHIUM	7.8
1 + E.P. ADDITIVE	2	LITHIUM	3.7

* ESSENTIALLY THE SAME AS #1 USING A HEAVIER BASE OIL

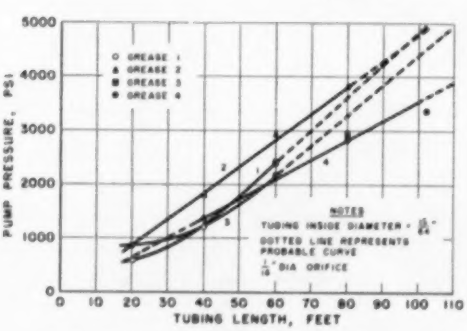
† SUBJECT TO A CONSTANT PRESSURE OF 100-LB AT ROOM TEMPERATURE FOR A PERIOD OF 22-HOURS

FIGURE 3



FLOW OF LUBRICATING GREASES AT ROOM TEMPERATURE

FIGURE 4



VARIATION AT ROOM TEMPERATURE OF DELIVERY PUMP PRESSURE WITH LENGTH OF DELIVERY TUBE

FIGURE 5

Figure 4 shows a plot of the pressure to pump one gram of grease (lbs./sq. in.) as the ordinate, against tubing length (ft.) as the abscissa. The representative curve for grease 2 (No. 2 lithium base), shows that this grease is somewhat difficult to pump through the different lengths of tubing utilized. Grease 3 (No. 2 barium base) shows a curve more or less parallel (throughout its entire length) with that of grease 2. However, the curve for grease 1 (No. 2 lithium base) varies from one extreme to the other. For tubing lengths up to approximately 45 ft., grease 1 is the least difficult to pump of the greases tested. However, this situation reverses itself when more than 45 ft. of tubing is involved, and this grease then becomes the most difficult to pump. The slope of the curve obtained from the study of grease 4 (No. 2 lithium base) is much less than that of the others; hence, it shows the opposite effect from grease 1, varying from the most difficult grease to pump under 45 ft. to the least difficult to pump over 45 ft. Information of this nature is of course most valuable to plant personnel and enables them to select lubricating greases that will give the best results for their individual purposes.

Figure 5 is an interesting version of the above tests; however, in this case, delivery pump pressure is plotted as the ordinate against tubing length as the abscissa. Here again, the same trend previously described is evident in that curves 1 and 4 cross over the others and show reverse effects when going from short to long lengths of delivery tubing. This chart is especially important because of the fact that when the length of delivery tubing is known, it is possible to determine (from the graph) the minimum pump pressure necessary to produce grease flow. Conversely, when the pump capacity is known, the maximum length of tubing that can be utilized for a given operation can be found.

III. Conclusion

In the preceding discussion, data have been presented from laboratory tests in which it is believed shear stress plays an important part. Even though no direct values for either shear stress or rate of shear can be given, the results of this work may aid in the formation of a worthwhile ASTM program.

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Patents and Developments

Grease Containing Dihydroxystearic Acid Soap

Lubricating greases containing, as a thickener, a complex soap of di-hydroxystearic acid and a low molecular weight aliphatic carboxylic acid having not more than 5 carbon atoms per molecule, are disclosed in the Esso Research & Engineering Company patent 2,712,527. Although hydroxystearic acid soaps have been used, particularly in lithium greases, attempts to produce satisfactory water-insoluble greases with soaps of such acids are claimed to have not been too successful. When lithium dihydroxystearate is incorporated in greases, for example, the resultant products, while exhibiting some grease structure, are soft and tend to separate oil readily. On application of mechanical stress, they are claimed to break down to soft fluid masses.

This advantage is said to be overcome by co-neutralization of the di-hydroxystearic acid and the low molecular weight aliphatic carboxylic acid with a suitable soap-forming base. The hydroxy acid preferably is prepared by a condensation reaction with hydrogen peroxide, which may be carried out in presence of a low molecular weight aliphatic carboxylic acid convertable to the desired complex soap.

The low molecular weight acid may be formic, acetic, propionic, butyric, valeric, furoic, acrylic and similar acids. The metal bases may be Li, Na, K, Ca, Ba or Al. Lithium hydroxide forms complex soaps of satisfactory water solubility, greatest stability and high dropping point.

Greases in accordance with the patent are normally prepared by preforming the complex soap thickener and incorporating the same in the lubricating oil in grease making proportions of about 10-40 wt. per cent. For this purpose, the di-hydroxystearic acid may be melted in water at temperatures of about 130°-180° F. The low molecular weight acid may then be added to the liquid mass. The combined acids may be co-neutralized with a boiling aqueous solution of metal hydroxide. Usually a slight excess of the metal base, say about 0.25-2.0% over that theoretically required for complete neutralization is employed. The soap formed is dried at temperatures below the fusion point of the soap, say about 180°-250° F.

The following is an example of the preparation of a lithium base grease:

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Unsaponifiable (Wool Grease Alcohols)	6% max.
Saponifiable	94%
Free Fatty Acid (as oleic)	55-60%
Actual Free Fatty Acid Content	90%
Saponification No.	120-130
Free Inorganic Acid	0.2% max.
Iodine Value	20-40
Apparent Solidification Point (titre)	Approx. 44° C.
Softening Point	45-48° C.
% Sulfur	No corrosive sulfur

A.O.C.S. Methods

Attempts to thicken mineral oil with the soap of the patent alone were not entirely successful, due to only partial solubility of the soap. However, excellent greases having good structural stability are obtained when only a portion of the thickener consists of the complex soap, the balance of the thickener consisting of lithium stearate. This is demonstrated by the following data.

Ingredients:	Wt. per cent
Complex lithium di-hydroxystearate-lithium formate in 1:1 mol ratio	5.0

Ingredients:	Wt. per cent
Lithium stearate	10.0
Naphthenic lubricating oil blend having a viscosity of 40 SSU at 210° F.	84.0
Phenyl alpha-naphthylamine	1.0

The complex lithium soaps of di-hydroxystearic acid and formic acid prepared as described in Example II and the simple soap, separately preformed lithium stearate, were combined and slurried in the lubricating oil and heated, while stirring, to 450° F. Phenyl alpha-naphthylamine was added and the grease drawn into pans for cooling. On cooling the grease was returned to the kettle and stirred to homogeneous product. This grease may be homogenized or milled before packaging, if desired.

Properties:	
Appearance	(1)
Dropping point, °F	385
Penetrations, 77°. mm./10—	
Unworked after homogenization	265
Worked 60 strokes	270
Structural stability, mm./10—(worked 100,000 strokes fine hole worker 270-1/16" hole plates)	345
Water washing test, per cent loss (AN-G-15 Method)	None
Norma-Hoffman oxidation—5 p.s.i. drop in oxygen pressure, hrs.	245

[1]Excellent, smooth, buttery grease.

Aerogel-Thickened Greases

In the past, a number of patents were mentioned as issued to the National Research Council of Canada, dealing with the improvement in water-resistance of inorganic gel-thickened greases. U. S. Patent 2,583,605 discloses the waterproofing of such gels with an alkyd resin which may be optionally modified with a drying oil.

In recently issued patent 2,714,091, the silica aerogel is added to a drying oil dissolved in the lubricating oil, and the mixture is heated, say to 125°C. for 2 hours, to effect polymerization and waterproofing of the gel. A catalyst may be used, if desired.

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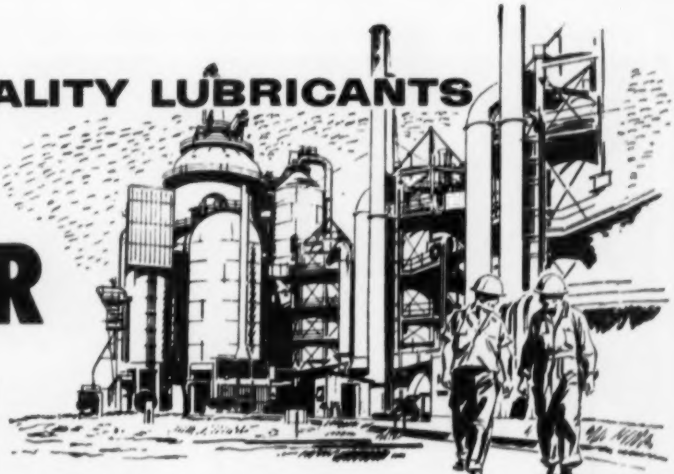

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The following is an example of the simple process involved:

	Per Cent
Dehydrated castor oil	3
Silica aerogel	10
Mineral lubricating oil (300 visc. 95 V. I.)	87

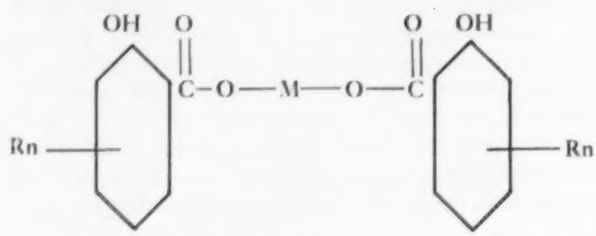
These ingredients were heated with stirring at 125° C. The grease withstood 90 cycles of the plunger in the standard water test after 1 hour and over 150 cycles after 2½ hours, in each case after treatment in a colloid mill.

Lithium Base Grease Containing Group II Divalent Metal Alkyl Salicylate as Copper Corrosion Inhibitor

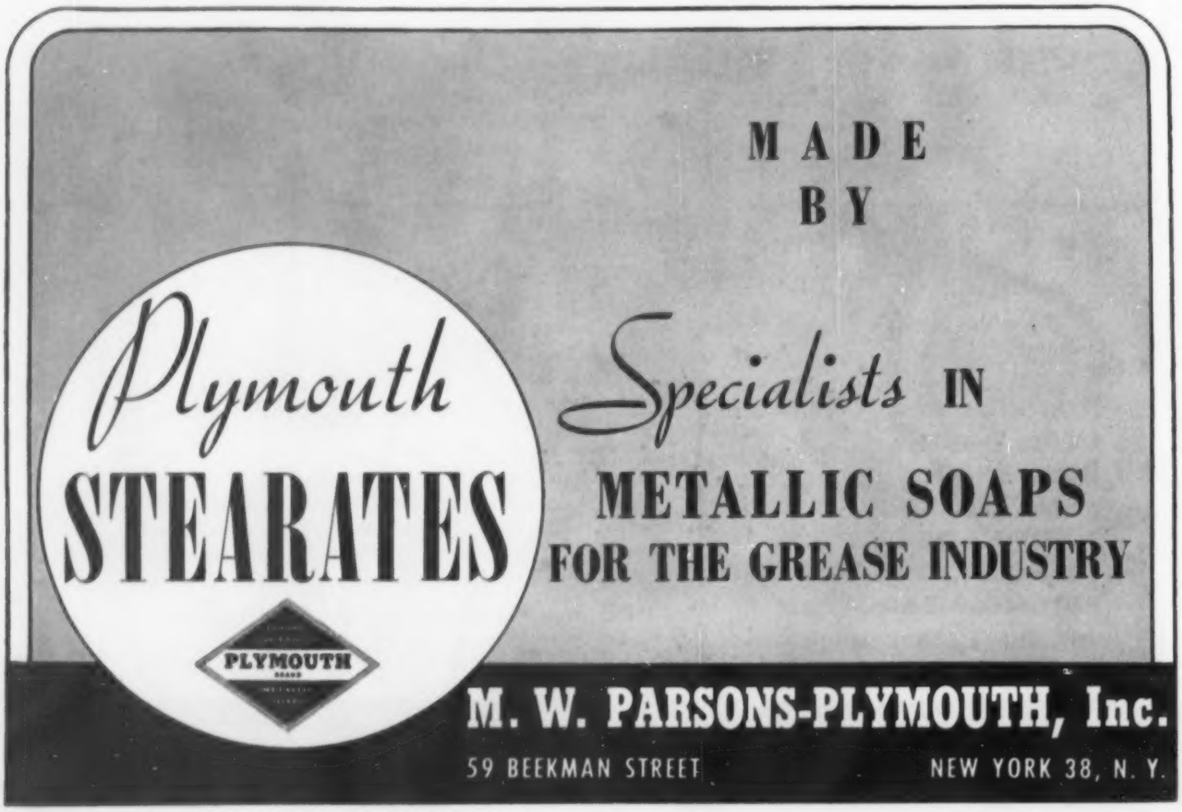
Lithium base lubricating grease compositions have found important use in aircraft controls and for other purposes where operation over a wide temperature range, and particularly operation at extremely low temperatures, is encountered. U. S. Patent No. 2,450,221 is typical of a lithium base grease of this type prepared from a lithium soap of hydroxy fatty acid or the glyceride thereof, such as hydrogenated castor oil, and containing as the major proportion of the liquid lubricating base an oil-soluble high molecular weight high boiling liquid aliphatic dicarboxylic acid ester within the lubricating oil viscosity range and possessing lubricating properties. As disclosed therein, the lithium soap may be formed from a major proportion of the hydroxy fatty acid or glyceride and a minor proportion of a saturated fatty acid, such as for example a 3:1 mixture of hydrogenated castor oil or 12-hydroxystearic acid with stearic acid. Such greases have exceptional shear and texture stability over a wide temperature range and under high shearing stress, and possess excellent low temperature properties.

While the lithium base greases of the aforesaid type have proved satisfactory in service, the increased use of copper and copper alloys in certain applications, particularly in aircraft and artillery control instruments, has introduced an additional problem of rendering the grease non-corrosive to copper in long time service. For this purpose, U. S. Army Specification 2-134 has prescribed a rigorous copper corrosion test for qualification under this specification. In attempting to meet this specification, it has been found that corrosion inhibitors heretofore employed in greases are ineffective.

In U. S. Patent 2,714,092 issued to The Texas Company, a lithium base grease is claimed to be effectively inhibited against copper corrosion by incorporation of preferably 1-3% of an oil soluble metal alkyl salicylate of the formula



where R is an alkyl radical having from 5 to 30 carbon atoms, n represents the number of hydrogen atoms on



the benzene nucleus which have been substituted by R and is a whole number from 1 to 3, the total number of carbon atoms in the said alkyl substitution on each benzene nucleus being at least 10 and preferably about 18 to 30 or more, and M is a divalent metal of group II of the periodic table selected from the group consisting of zinc, magnesium, barium, calcium, and strontium.

The metal alkyl salicylates which are effective copper corrosion inhibitors are preferably prepared from phenol by alkylation with an olefin polymer fraction to produce an alkyl phenol with the desired alkyl substitution on the benzene nucleus; the latter is converted to sodium alkyl phenolate by the sodium methylate procedure; the sodium alkyl phenolate is then carbonated under carbon dioxide pressure and elevated temperature followed by acidification to form alkyl salicylic acid; and the latter is then converted to the group II metal alkyl salicylate by refluxing with an organic solvent, such as xylene, in the presence of a soluble group II metal salt, such as the acetate. The final product is preferably prepared in the form of a concentrate in a mineral lubricating oil, such as a 25-50 per cent concentrate. Where a lower molecular weight olefin, such as amylene is used for alkylation of the phenol, the latter is dialkylated or trialkylated to provide a total of at least 10 carbon atoms in the substituent alkyl groups. Where a high molecular weight olefin is employed, such for example as a propylene or butylene polymer fraction having olefins of 18 to 30 carbon atoms in the molecule, the product is generally mono-alkylated.

Typical compounds useful for purposes of the patent are zinc alkyl salicylate, wherein each benzene nucleus is mono-alkylated with a C_{18} to C_{30} alkyl group, or dialkylated with C_5 to C_9 alkyl groups; similar compounds of barium, such as barium diamyl salicylate; similar compounds of calcium such as calcium dinonyl salicylate; and similar compounds of magnesium such as magnesium C_{21} alkyl salicylate.

The patent gives details for the preparation of such inhibitors.

The following specific example is given to illustrate the patent. I lithium base grease was prepared from a fatty material consisting of about 75 per cent by weight of stearic acid. The lubricating base used was a mixture of about 75 per cent by weight of di-isoocytl adipate with about 25 per cent by weight of a paraffin base mineral lubricating oil having an SUS viscosity at 100° F. of about 100. The method of preparation involved charging a steam heated kettle with the required amount of 10.3 per cent of lithium hydroxide solution together with a small amount of water, the hydrogenated castor oil and a proportion of the paraffin base mineral lubricating oil, the latter being less than the amount of hydrogenated castor oil and generally about one-half to two-thirds of the latter. The kettle contents were held at 170-200° F. for about four hours with agitation, and then the stearic acid was added and the temperature maintained with stirring for another 1-2 hours to complete saponification. Following saponification, a 25 per cent concentrate of an octyl methacrylate ester polymer in a mineral lubricating oil, which is sold commercially by Rohm and Haas

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under the name "Acryloid HF-600," was added in an amount to provide 1.9 per cent by weight of the concentrate or approximately 0.5 per cent by weight of the active polymer in the final grease composition.

The saponified mix was then heated with stirring at 290 to 330° F. for about four hours to effect dehydration. The balance of the mineral lubricating oil was then added with stirring as the kettle contents cooled down to below 280° F. Phenyl alphanaphthylamine in an amount of 0.5 per cent by weight based on the grease was added as an oxidation inhibitor, together with 1 per cent by weight of dibenzyl disulfide and 2 per cent by weight of sorbitan monooleate and a small amount of a dye. The resulting base grease was drawn at a temperature below 200° F.

The resulting base grease had the following calculated composition:

	Weight per cent
Lithium soap of hydrogenated castor oil	12.2
Lithium stearate	4.3
Excess LiOH	0.2
Glycerine (from saponification of hydrogenated castor oil)	1.2
Paraffin base lubricating oil	19.2
Di-isooctyl adipate	57.5
Sorbitan monooleate	2.0
Dibenzyl disulfide	1.0
"Acryloid HF-600"	1.9
Phenyl alphanaphthylamine	0.5
Dye	0.0026

To separate portions of the foregoing base grease, amounts of the above described zinc C_{23} alkyl salicylate were added to provide 1 per cent and 3 per cent by weight based on the total grease composition respectively. The said greases were then subjected to the copper corrosion test of the 2-134 specification, in comparison with the base grease, with the results as shown in the following table:

to be rated as passing.

As will be noted from the foregoing table, even the base grease which contained 0.5 per cent by weight of phenyl alphanaphthylamine, an effective oxidation inhibitor, showed no pressure drop in the test, indicating that the copper corrosion which resulted with the base grease is not attributable to normal oxidation. Likewise, and as set forth in U. S. Patent No. 2,610,946, recognized copper corrosion inhibitors which are effective in other relationships are completely ineffective for purposes of the present invention. As shown by samples 2 and 3 of the foregoing table, the zinc alkyl salicylate was surprisingly effective in enabling the grease to pass this rigorous copper corrosion test. While materials of this general character have heretofore been proposed as detergent additives for lubricating oils, such as motor oils, it was claimed to be entirely unexpected that these particular group II metal alkyl salicylates as above defined should be effective as a copper corrosion inhibitor in the new environment of a lithium base grease.

Silicone Greases Containing Surface-Esterified Siliceous Solids

An estersil-silicone oil lubricating grease claimed to be highly resistant to physical deterioration by water, is described in great detail in the DuPont patent 2,705,700.

A grease is ordinarily made by thickening a lubricating oil with a thickening agent such as a soap. Greases made with many such conventional thickeners are quite sensitive to moisture and at high relative humidities, even though no liquid water may be present, show signs of deterioration. Lack of water resistance is manifested by such changes as loss of clarity, thinning of the grease upon standing in contact with high relative humidity, and actual separation of oil and thickening agent. When the latter change occurs the grease loses body and becomes practically valueless for its intended purposes.

2-134 Cu Corrosion Test

Additive Wt. Per Cent	*Copper*	*Grease*	*Rating*	*Pressure Drop*
	Brown Stain	Rust colored		
1. Base Grease	No change;	do	Fail	0
2. Base Grease 1% Zinc C_{23} alkyl salicylate	slight brown stain in duplicate test.		Pass; borderline	0
3. Base Grease 3% Zinc C_{23} alkyl salicylate	No change	do	Pass	0

The 2-134 corrosion test of the foregoing table was run by placing a copper strip in a Norma Hoffman bomb so as to be partially immersed in the sample of the grease under test, and then maintaining the bomb under oxygen pressure (110 pounds per square inch initial pressure) at 210° F. for 20 hours. During that period no pressure drop due to oxygen absorption must occur. Then, at the completion of the 20 hour period, both samples of grease and copper strip are inspected. There must be no more than a very faint stain on the copper strip and no more than a slight stain or discoloration on the grease in order

By using an estersil as the thickening agent for a lubricating oil, greases are claimed to be produced which are resistant to high relative humidities. They can be stored for long periods in water-saturated atmospheres without showing signs of deterioration and can therefore be said to have water resistance. On the other hand, there are extreme conditions of use, such as in the lubrication of bearings on drum dryers and similar chemical equipment, where the greases must be in contact with liquid water at or near the boiling point, and under these conditions even greases made by thickening ordinary lubricating oils

with estersils do not have the desired degree of water resistance.

Now, according to this patent, silicone oils can be thickened with estersils to give greases of extreme water resistance. The silicone oil component of such greases is quite expensive and is not as efficient a lubricant as the more common hydrocarbon oils, and hence preferred aspects of the invention are directed to estersil compositions containing a small proportion of silicone oil adapted to be mixed with a larger proportion of another lubricating oil, and to the three-component greases, produced by such admixture, containing an estersil, a silicone oil and another water-insoluble lubricating oil.

In producing water resistance, the combination of an estersil and a silicone oil appears to be synergistic, since it has been found that the desired degree of water resistance cannot be imparted to an ordinary finely divided, non-esterified siliceous thickener by adding a silicone oil thereto. Likewise, a grease made with non-esterified silica and silicone oil together with another lubricating oil such as hydrocarbon oil is similarly lacking in resistance to water under extreme conditions. Whether this synergism is due to an orientation among the estersil, the silicone oil, and the lubricating oil or is to be accounted for on other grounds is not entirely clear; suffice it to say that the synergistic effect is easily observable in practical tests such as by placing a sample of the grease in boiling water and noting the time required for the boiling water to cause thinning and separation of the grease into its component parts.

Details are given in preparation of the estersil, the substrate of which is an inorganic siliceous material having a specific surface area of at least one square meter per gram, esterfied with a primary or secondary alcohol in which the hydrocarbon radicals have 2-18 carbon atoms.

Reference is made to the patent for details which are quite lengthy.

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Industry NEWS

Deep Rock Increases Company Service Stations

The Deep Rock Oil Company, pushing a policy of enlarging and improving its marketing outlets, has purchased nine independent service stations in the Oklahoma City area, and has announced plans to build two company-owned "super-stations."

The combined expansion represents the first move in this direction since Kerr-McGee Oil Industries, Inc., acquired the operating assets of Deep Rock in a $17 million transaction this spring.

F. C. Love, president of the Deep Rock Oil Company, said the company has purchased the properties of the Blalack Oil Company covering nine service stations in Oklahoma City.

Deep Rock has purchased two plots of ground in suburban locations on which to build a pair of "new look" service stations. Plans for a modernistic new type of service station, of concrete, porcelain, glass and steel, have been approved.

Property acquired includes a 125 by 100-foot plot at SW 44th and Pennsylvania, and a 4½ acre tract at NW 23rd and Portland. Part of the land included in the 23rd and North Portland purchase will be used for development of a shopping area.

The buildings planned for the two locations will set the trend for all company-built Deep Rock stations. Long, low lines are used in a design that couples beauty with usefulness. The exterior will be white porcelain enamel over concrete and steel construction, with sizeable areas of the walls left free for windows. Only color on the exterior of the building will be slender color bands along the leading edge of the roof, showing the blue and yellow of Deep Rock. A floating flower box, set in the corner of the front window, will hold blooming plants in summer and dwarf evergreens in winter.

The lubritorium will be separated from the sales office by a glass wall. The interior walls of the station will be white, except for the Deep Rock blue wall at the back of the lubritorium. Rest rooms will be tiled, with white porcelain reaching midway up the wall. Above the wainscoting in the men's room, walls will be Como blue—in the ladies' room, walls will be seafoam green. The ladies' rest room will include a built-in vanity table.

"Our aim is to make our stations welcome stopping places through pleasant, homelike design," Love said. "Color will be used to keynote the cheerful atmosphere."

Service islands will be gray and will feature Deep Rock's new canopy lighting, a diffused cold light. Mercury vapor lights overhead will give the stations a near daylight effect after dark.

The stations were designed to fit Deep Rock's specifications by Sorey, Hill and Sorey, Oklahoma City architectural firm. The basic design will remain unchanged for all stations—the arrangement permits construction of the station as a sales office only, with one or two bays in the lubritorium. Additions may be made without changing the flow or continunity of the lines of design.

Locations of the nine Blalack stations added to Deep Rock's family of retail outlets: 5101 N. Western; 6401 N. May; 3020 NW 23rd; 2040 NW 23rd; 9216 N. Western; and, closed for repairs, 1224 NW 16th and 2900 NW 16th; and, not to be branded, 2419 Classen Boulevard and 1306 E. Reno.

Other Deep Rock stations in the Oklahoma City area, served by jobbers H. H. Edwards, Jr. and J. D. Gauntt, included 75th and NE Highway; Main and Western; 402 S. Robinson; 25th and Classen; 8th and Lindsay; 18th and Eastern, and 819 NW Britton road.

New Tulsa Building For Shell

Plans for the construction of a new 10-story building in Tulsa which will serve as headquarters for Shell Oil Company's Tulsa Area operations were announced by the Sunflower Corporation.

Construction of the two-million dollar structure, to be known as the Shell Building, will begin approximately January 1 and is expected to be completed by June 1, 1957.

The top six floors of the new building will be occupied by approximately 400 employees of Shell's Tulsa Area which is responsible for the company's exploration and production activities in Oklahoma, Kansas, Illinois, Indiana, Ohio, Michigan, Kentucky, Tennessee, and north Texas.

Shell also plans to have an employment office in the lobby, and Shell Pipe Line Corporation will maintain communications offices on the third floor. Remaining floors will be occupied by business and professional offices.

The new Shell Building in Tulsa will overlook Boulder Park. The re-

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inforced concrete structure will have an entirely open second floor which is designed as one of three parking levels with direct access to elevators.

Street floor facilities will include business locations on the north, main lobby in the center, and parking area on the south. Entrances to the lobby will be located on the Baltimore Avenue and Boulder Park sides of the building.

The exterior of the completely air conditioned building will include vertical panels of cream and sand-colored brick. Horizontal soft green canopies over the individual patterned windows, together with green solex window glass, will reduce sun glare and heat during office hours.

Officers of the Sunflower Corporation of Tulsa, recently organized to finance and operate the building, include: M. Murray McCune, president; Gordan A. McCune, vice president; and C. W. Flint, Jr., secretary-treasurer. Plans were prepared for the building by McCune, McCune and McCune, and the Tulsa Rig, Reel and Manufacturing Company will do the actual construction.

Announcement of the new building was made by Shell vice president C. P. Bristol who directs the operations of the Tulsa Area. Shell first established offices in Tulsa in 1912 with 12 employees. Today the Tulsa Area includes 1,350 employees, division offices at Wichita Falls, Texas; Oklahoma City, Oklahoma; Wichita, Kansas; and Centralia, Illinois; and district offices at Amarillo, Texas; Ardmore and Elk City, Oklahoma; Great Bend, Kansas; and Evansville, Indiana.

Cinderella Success Story of LP-Gas Told in Gulf Booklet

The amazing success story of liquefied petroleum gas, whose consumption has skyrocketed upward by 27,500% in 30 years, is told in a new brochure entitled "LP-Gas, the Cinderella Fuel."

The three-color booklet is illustrated and readable in 15 minutes. It provides the most up-to-date, layman's description of an industry second only to television in growth rate, and with an estimated consumption of 5½ billion gallons in 1955.

Copies are available for distribution to individuals, schools or other groups, upon request to Gulf Oil Corporation, Pittsburgh, Pa., which has published the brochure as a public information service.

The text carries the reader through a non-technical explanation of the history, characteristics, production, transportation and use of LP-Gas.

Stressed as responsible for its "Cinderella" growth are its high thermal value, economical transportation as a liquid—which expands 270 times when used as gas—and its supplying its own pressure-feed to appliances.

How this fuel is commercially recovered from crude oil and natural gas, and current methods of transportation including tankers and plans for pipeline movement are discussed. In homes, the booklet reveals a trend toward larger, fixed tanks in place of exchangeable cylinders.

The multiplying uses for the gas are listed (the latest being LP-Gas air conditioning) for the home and farm, in industry where there are now 25 applications, and in the chemical, transport and utilities fields.

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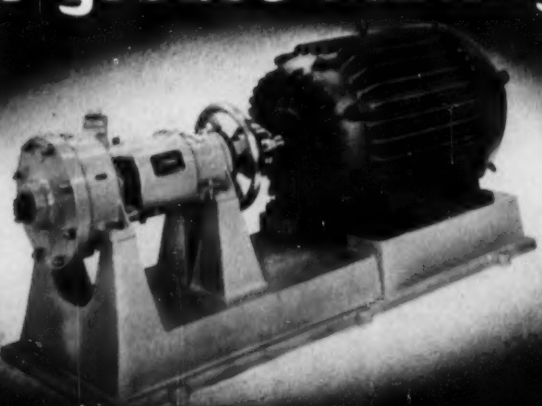

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PEOPLE in the Industry

Continental Can Company Elects Officers

THOMAS C. FOGARTY

REUBEN L. PERIN

ORREN R. McJUNKINS

HORACE M. BLINN

The board of directors of Continental Can Company has elected Thomas C. Fogarty president of the company, effective January 1, to fill the vacancy that will be created on that date by the retirement of Hans A. Eggerss, it was announced by General Lucius D. Clay, chairman of the board.

He also announced three other Metal Division promotions to become effective on that same date. Reuben L. Perin, vice president of the Eastern Division, has been elected executive vice president of the Metal Division, the position held by Mr. Fogarty since 1950.

Orren R. McJunkins, general manager of the Southeastern District, has been promoted to vice president in charge of the Eastern Division, and Horace M. Blinn, general manager of the California District of the Pacific Division, has been elected vice president in charge of that division to fill the vacancy that will be created by the retirement of Sherlock McKewen.

THOMAS C. FOGARTY

President of Continental Can Company

Former executive vice president of the Metal Division, Mr. Fogarty has been with Continental since 1929. Four years later, he was named a division sales manager, a position that he held until 1944, when he was appointed Eastern Division sales manager. In 1946, he was elected vice president in charge of sales. Following his election, in 1950, as executive vice president of the Metal Division, he was elected in 1951, to the company's board of directors.

REUBEN L. PERIN

Executive Vice President, (Metal) Division

Former vice president of the Eastern (Metal) Division, Mr. Perin joined Continental in 1928. After two years in the sales department, he served as district sales manager in Cincinnati and in Chicago. In April, 1942, he was named sales manager of the Pacific Division, with headquarters in San Francisco, where he remained until 1944, when he was named general sales manager in Chicago. He was transferred to New York in 1949 as general sales manager, and was elected vice president in charge of the Eastern (Metal) Division in June, 1950.

ORREN R. McJUNKINS

Vice President, Eastern (Metal) Division

Former general manager of the southeastern district of the Eastern Metal Division, Mr. McJunkins joined Continental in January, 1952, as special assistant to the manager of manufacturing in the Eastern Division. In June of that year, he was named special assistant to the vice president of the Eastern Division, and in January, 1953, he was appointed general manager of the southeastern district.

HORACE M. BLINN

Vice President, Pacific (Metal) Division

Former general manager of the California district of the Pacific (Metal) Division, Mr. Blinn has been associated with Continental since 1929. After three years at the company's Cincinnati plant, he was transferred to the sales department, becoming district sales manager in Cincinnati in 1943. In 1948, he was transferred to San Francisco as district sales manager. In 1950, he was named assistant sales manager of the Pacific division. He was appointed division manager of sales in 1951 and held that position until 1954, when he became general manager of the California district.

Kerr-McGee Appoints Drilling Manager

G. Otis Danielson has been appointed by Kerr-McGee Oil Industries, Inc., as manager of drilling operations in the company's Gulf Coast Region.

The move became effective December 1. Danielson was formerly Manager of drilling operations in Kermac's Mid-Continent Region, which includes the Oklahoma-Texas and Rocky Mountain Divisions.

Danielson has been with the company since April 5, 1940, a few months after his graduation from the University of Oklahoma with majors in petroleum engineering and geology. At that time the company was known as the Kerlyn Oil company, and Danielson went to work as a roughneck.

In August, 1951, Danielson was named chief drilling engineer for Kerr-McGee. He has been in his present position since November 23, 1954.

Danielson's present duties will be split three ways. George B. Parks, general manager of production and drilling operations, will assume part of the duties and responsibilities of the office.

Norman Baxendale will fill the position of general drilling superintendent of the Mid-Continent Region, assuming the balance of duties previously assigned to the office of manager of the Mid-Continent Region. Drilling superintendents of the region's two districts will report to Baxendale.

Bidding and contracting section of the Mid-Continent Region will be placed under the supervision of J. W. Bawcom.

The position of manager of drilling operations in the Gulf Coast Region has been vacant for several months, with duties of the office performed by Parks.

Du Pont Retires J. W. Kinsman

For reasons of health, J. Warren Kinsman has brought to a close a career of more than 40 years with the Du Pont Company, submitting his resignation from the Board of Directors.

This action, accepted by the Board at its regular monthly meeting, carried with it his retirement as a vice-president and member of the Executive Committee. Under company pension provisions, any employee can retire at age 60 provided he has 30 or more years of service.

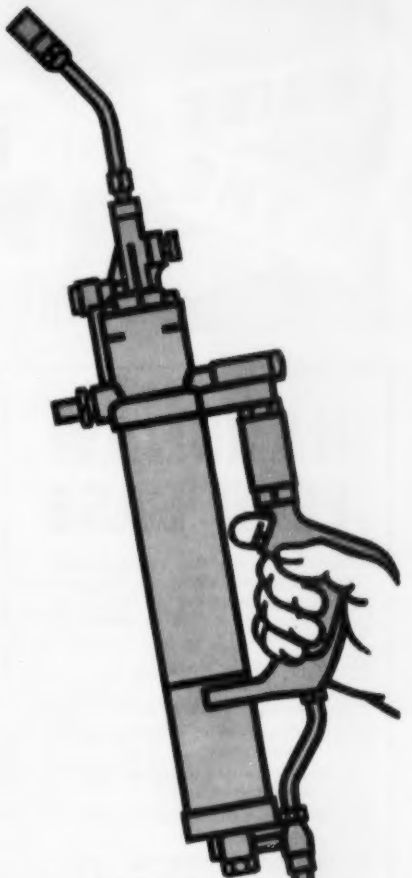
It was announced at the conclusion of the November meeting that the number of directors has been reduced from 30 to 29, and the membership of the Executive Committee from 10 to nine.

Mr. Kinsman, who worked his way up through the ranks to the highest echelons of company management, joined the Du Pont Company in 1915 as a timekeeper in the Bayway, N.J., plant of the High Explosives Operating Department. He became a general foreman there before being transferred for a brief period in 1917 to the Du Pont Fabrikoid Company.

He next moved to the sales department of the former Du Pont Chemical Works. In 1918 he went to the Carney's Point N.J., smokeless powder plant as an assistant supervisor, and at the end of the first World War he returned to the sales department of the Chemical Works. Two years later he was made a special assistant in the Dyestuffs Department.

In 1924 he was appointed assistant director of sales of the Dyestuffs Department, and five years later was made director of sales of the Organic Chemicals Division. In 1931, when the Organic Chemicals Department was formed, he became director of sales for Intermediates and Exports and manager of the Alcohol Division.

Ten years later he was appointed



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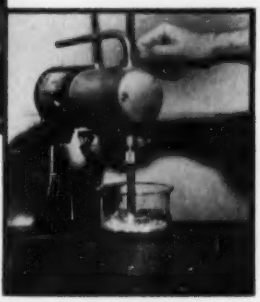
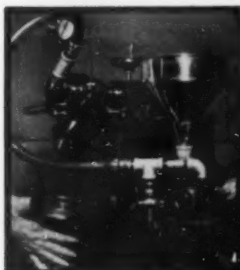
Multi-Tested for a Thousand Uses!

EXACT FORMULATION — various formulas are tested until one is produced that meets all of manufacturer's requirements.

MIXING—mixing prepares formula for milling.

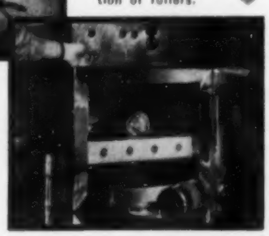




MILLING—milling or homogenizing produces a smooth, consistently uniform grease.

EXACT CONSISTENCY — penetrometer tests indicate consistency or hardness of grease sample and determine the plasticity of the formula.

EXCELLENT MECHANICAL STABILITY — roller tests measure mechanical stability of grease and produce a numerical evaluation — during penetration testing — of the change in consistency caused by kneading or working action of rollers.



HIGH SHEAR STABILITY—shear stability tests exert influence far in excess of any working pressures for which grease will be used.

EVERY DAY Baroid's extensive laboratories assist grease compounders to formulate greases with Bentone* 34 gelling agents. Compounders throughout the country have used Baroid laboratory service to obtain the best formula – using *their* oil and Bentone* 34 – to make a grease that's right for thousands of applications. For the farm . . . automotive industry . . . industrial machinery of every kind – grease made with Bentone* 34 serves a need not met by any other type of lubrication. Its unique composition has a tenacious quality that causes it to adhere to metal . . . has a matchless resistance against rain and washout . . . works well under both *extreme* high and low temperatures! It answers a multitude of lubrication problems because one Bentone grease is good for scores more applications than any known conventional lubricant.

Bentone grease is always uniform, always the same high quality. Write today for illustrated brochure about Bentone* 34 gelling agent.

BENTONE* 34

THE NON-SOAP GELLING AGENT

Dutch Boy* TRADEMARKS REGISTERED U. S. PAT. OFF.

NATIONAL LEAD COMPANY ★ BAROID DIVISION

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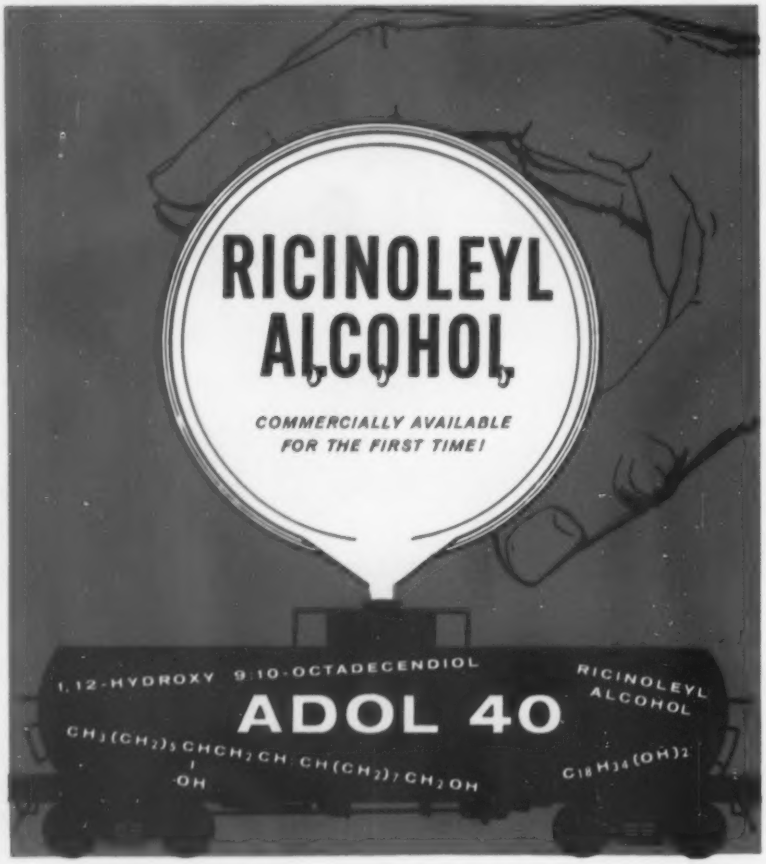

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HEAT STABLE • NON-CORROSIVE

RANCID RESISTANT

This new highly stable, long chain (C_{18}) unsaturated fatty diol derived from castor offers unlimited reaction possibilities in the manufacture of cosmetics, polyester modifiers, surfactants and quaternary derivatives.

It has three chemically reactive positions with two Hydroxyl groups and a double bond.

Adol 40 is readily soluble as well as being an excellent solvent for chemicals. It is a clear, liquid, non-drying alcohol with a cloud point below 10°F. Available for the first time in tank car and LCL quantities, this material offers new and limitless reaction possibilities.

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COMPANY______
CITY______ ZONE______ STATE______

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assistant general manager of the Plastics Department. In 1943 he returned to the Organic Chemicals Department as assistant general manager. Under his leadership the company's rubber chemicals, petroleum chemicals, and agricultural disinfectants laboratories and businesses were established.

He was also active in the research on and development of accelerators, antioxidants and colors for rubber, flotation agents, disinfectants, wood-preservatives, refrigerants, extreme-pressure lubricant bases, fluorescent dyes, metal deactivators and addition agents for petroleum fuels and lubricants.

He became general manager of the Fabrics and Finishes Department in 1944. Two years later he was elected to membership on the Board of Directors, and in 1947 he became a vice-president and member of the Executive Committee, where his special fields were sales, advertising and market research. He has been an officer and director of a number of the Du Pont Company's affiliated corporations.

Mr. Kinsman is a native of Elizabeth, N.J., and attended Wesleyan University. He is vice-president of the Board of Trustees of that institution, which conferred upon him in 1953 the honorary degree of Doctor of Laws for his contributions to public understanding of the American enterprise system.

He has been active in and an officer of many business and trade associations at various times, and in 1954 the National Association of Manufacturers elected him an honorary vice-president for life. Currently he is also a director of the National Sales Executives, Inc., and a member of the Marketing Executives Society.

Shell Oil Names R.W.McOmie Refineries Manager

R. W. McOmie, manager of Shell Oil Company's new refinery at Anacortes, Washington, has been appointed general manager of refineries in the company's head office in New York effective January 1, it was announced by F. S. Clulow, vice president of manufacturing.

He will be succeeded as manager at Anacortes by R. C. Barton, who is now superintendent of the refinery.

Mr. McOmie, a native of Idaho

and a graduate of Stanford University, joined Shell in 1927 as a chemist at the Martinez, California, refinery. He progressed through various positions in Shell's west coast refineries and in 1943 was named assistant refinery manager at Wilmington, California. He was promoted to refinery manager there in 1946, a position he held until his assignment to Anacortes.

While the Anacortes Refinery was under construction, Mr. McOmie was in charge of coordinating the various company activities associated with its construction as well as the development and training of the operating personnel.

Mr. Barton joined Shell in 1934 as a chemist and has served in various operating and technical positions on the west coast. In 1949 he was appointed superintendent of the Martinez Refinery, a position he held until his assignment early this year to Anacortes. He will be succeeded as Anacortes refinery superintendent by J. B. Wyman, now assistant manager of Shell's New York manufacturing operations department.

Shell Oil Refining Vice-President to Retire

C. E. Davis, Shell Oil Company vice-president in charge of refining, will retire at the end of the year, after 38 years with the firm, it has been announced.

He will become a petroleum consultant and serve part time as general secretary of the Fifth World Petroleum Congress, which will convene in the United States in 1959. The World Petroleum Congress is an international forum for the exchange of technical information in the petroleum and allied industries.

During World War II, Mr. Davis served in the Petroleum Administration for War. From 1951 to 1953 he was with the Petroleum Administration for Defense. He is now chairman of the refining panel of the Military Petroleum Advisory Board.

Mr. Davis joined Shell in Oklahoma in 1917. After serving in various capacities in refineries in the Midwest, he became assistant to the manager of the manufacturing operations department in St. Louis in 1932. In 1938 he was made assistant to the vice president in charge of manufacturing and in 1943 he became general manager of manufacturing. He was promoted to the post of vice president in charge of manufacturing for Shell's East of the Rockies territory in 1945 and was named to his present position in 1949, when the company consolidated its nationwide activities.

In other changes effective January 1 in Shell's manufacturing department, R. W. McOmie, manager of the Anacortes, Wash., refinery, will become general manager of refineries, and L. R. Goldsmith, manager of manufacturing, will become general manager of technical departments.

Gulf Appoints Gregersen Production Representative

Mr. Albert Gregersen has been appointed Staff Representative for the Eastern Hemisphere Production Department, Gulf Oil Corporation.

In his new capacity, Mr. Gregersen will serve as the Pittsburgh General Office representative for the Vice President of the Eastern Hemisphere Production Department, C. W. Hamilton, who is stationed in London, England.

Acting for Mr. Hamilton in many matters, including representing him on the company's production Council and the President's Coordination Council, Mr. Gregersen's presence in Pittsburgh greatly expedites liaison and coordination between the Senior Vice President, Production, and the Production Office in London.

The latter office is immediately responsible for Gulf exploration and production activities throughout the Eastern Hemisphere.

Mr. Gregersen is a veteran of long experience, not only with Gulf, but as a practicing Geologist, with particular experience in the Eastern Hemisphere.

U. S. Steel Appoints Warren F. Hjerpe

Warren F. Hjerpe has been appointed manager of sales in the St. Louis district of U. S. Steel Supply Division of United States Steel Corporation, it was announced today by William J. Borwick, district manager.

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Hjerpe had been sales manager in Chicago for the supply division since April 1 and previously was assistant district manager, Chicago.

A native Chicagoan, he attended North Park High School and joined U. S. Steel as a sales correspondent in Chicago in 1946. Later he was transferred to Milwaukee as a sales correspondent.

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FUTURE MEETINGS of the Industry

JANUARY, 1956

9-13 SAE Annual Meeting, Sheraton-Cadillac Hotel and Hotel Statler, Detroit, Mich.

10-12 Kentucky Petroleum Marketers Assn. (30th annual meeting), Brown Hotel, Louisville, Ky.

25-26 Northwest Petroleum Association (annual convention), Nicollette Hotel, Minneapolis, Minn.

30 to Feb. 3 American Institute of Electrical Engrs. (1956 Winter general), Statler Hotel, New York, N. Y.

FEBRUARY, 1956

22-23 Iowa Independent Oil Jobbers Association, Inc. (convention), Fort Des Moines Hotel, Des Moines, Ia.

MARCH, 1956

7-9 American Petroleum Institute (Division of Production, Southern District Meeting), Plaza Hotel, San Antonio, Tex.

12-16 National Assn. of Corrosion Engrs. (annual convention), Statler Hotel, New York, N.Y.

19-21 Western Petroleum Refiners Association (annual meeting), Plaza Hotel, San Antonio, Tex.

20-22 Ohio Petroleum Marketers Assn., Inc. (Spring Convention & Trade Exposition), Deshler-Hilton, Columbus, Ohio.

21-23 American Petroleum Institute (Division of Production, Southwestern District Meeting), Texas Hotel, Fort Worth, Tex.

APRIL, 1956

2-4 American Institute of Electrical Engrs. (Southwest District No. 7), Dallas, Texas.

16-20 Greater New York Safety Council (annual convention and exposition), Statler Hotel, New York, N. Y.

18-20 National Petroleum Association, Cleveland, Ohio

22-26 National Tank Truck Carriers, Inc., Shoreham Hotel, Washington, D. C.

30 to May 1 Independent Petroleum Association of America (semiannual meeting), Statler Hotel, Los Angeles, Cal.

30 to May 2 Chamber of Commerce of the United States (annual meeting), Washington, D. C.

30 to May 4 American Petroleum Institute (safety and fire protection mid-year meeting), Warwick Hotel, Philadelphia, Pa.

JUNE, 1956

3-8 SAE Summer meeting, Chalfonte-Haddon Hall, Atlantic City, N. J.

17-22 ASTM 59th Annual Meeting and 12th Apparatus Exhibit, Chalfonte-Haddon Hall, Atlantic City, N. J.

SEPTEMBER, 1956

7-8 Desk & Derrick Club, New Orleans, La.

12-14 National Petroleum Association, Atlantic City, N. J.

16-22 ASTM 2nd Pacific Area National Meeting and Apparatus Exhibit, Hotel Statler, Los Angeles, Calif.

OCTOBER, 1956

22-24 NLGI ANNUAL MEETING Edgewater Beach Hotel, Chicago, Ill.

NOVEMBER, 1956

1-2 SAE National Diesel Engine Meeting, Drake Hotel, Chicago, Ill.

8-9 SAE National Fuels and Lubricants Meeting, The Mayo, Tulsa, Okla.

APRIL, 1957

16-18 National Petroleum Association, Cleveland, Ohio

JUNE, 1957

16-21 American Society for Testing Materials, Chalfonte-Haddon Hall, Atlantic City, N. J.

SEPTEMBER, 1957

11-13 National Petroleum Association, Atlantic City, N. J.

OCTOBER, 1957

28-30 NLGI ANNUAL MEETING Edgewater Beach Hotel, Chicago, Ill.

APRIL, 1958

16-18 National Petroleum Association, Cleveland, Ohio

JUNE, 1958

22-28 ASTM 61st Annual Meeting, Hotel Statler, Boston, Mass.

SEPTEMBER, 1958

10-12 National Petroleum Association, Atlantic City, N. J.

OCTOBER, 1958

27-29 NLGI ANNUAL MEETING Edgewater Beach Hotel, Chicago, Ill.

Foote LITHIUM HYDROXIDE

. . . as the key ingredient in multi-purpose lubricating grease manufacture, Foote lithium hydroxide enables the economical production of a single water resistant grease that lubricates effectively at both extremely high and low temperatures.

Plan your production schedule in terms of an assured supply of Foote lithium hydroxide.

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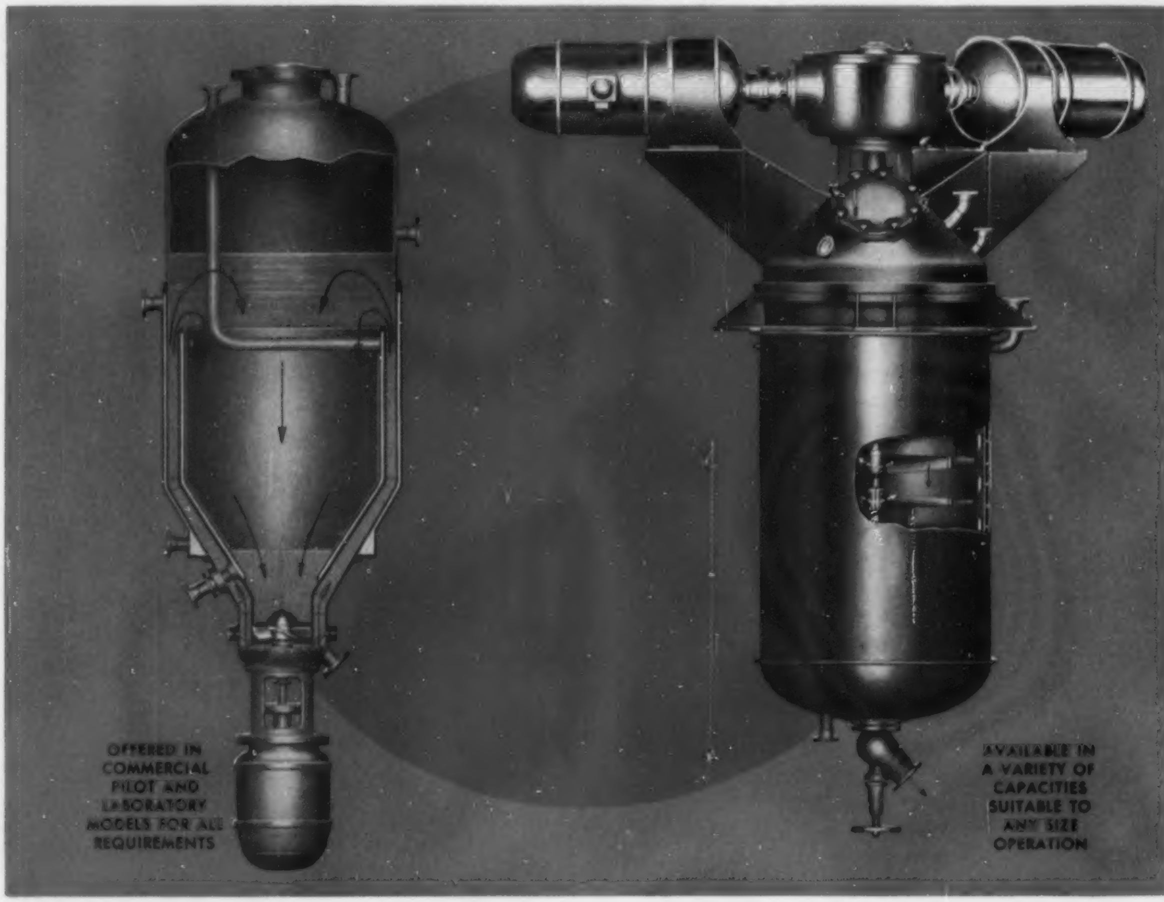

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The Stratco contactor provides continuous or batch mixing with very short time cycles, less soap, less manpower and laboratory control.

The Stratco Internal Circulation Double Stirrer Kettle adds further efficiency and economy through exceptionally good heating, mixing, kneading and cooling properties plus more rapid turnover.

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